

# The Fox Project: Advanced Development of Systems Software

R&D Status Report  
January 1 to March 31, 1998

School of Computer Science  
Carnegie Mellon University  
Pittsburgh, PA 15213

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The long-term objectives of the Carnegie Mellon Fox Project are to improve the design and construction of systems software and to further the development of advanced programming language technology. We use principles and techniques from the mathematical foundations of programming languages, including semantics, type theory, and logic, to design and implement systems software, including operating systems, network protocols, and distributed systems. Much of the implementation work is conducted in the Standard ML (SML) language, a modern functional programming language that provides polymorphism, first-class functions, exception handling, garbage collection, a parameterized module system, static typing, and a formal semantics. This Project involves several faculty members and spans a wide range of research areas, from (1) advanced compiler development to (2) language design to (3) software system safety infrastructure.

## **1 Research Progress**

For each of the three areas listed above, we report on the research accomplishments during the first calendar quarter of 1998, and the research objectives for the second quarter of 1998.

### **1.1 SML Compiler and System Development**

#### **Accomplishments (January-March):**

- Bootstrapped the version 2 of the TIL compiler (TILT). TILT compilation of TILT takes 2.5 hours of CPU time and generates a 10 megabyte executable.

#### **Objectives (April-June):**

- Measure the performance of MLRISC back-end with TIL1 compiler.
- Publish a technical report on the TIL2/MLRISC back-end.
- Complete initial release of the TILT compiler, without optimization phases.
- Distribute TIL1 compatible with SML97.

### **1.2 Language Design**

#### **Accomplishments (January-March):**

- Designed, implemented, and proved the correctness of a new type checker for the critical typed intermediate language of TILT. This significantly increased the efficiency of the compiler itself, and increased our confidence in its design.
- Completed the design and prototype implementation of an extension of the ML language with modal types.

**Objectives (April-June):**

- Complete the metatheory for the middle-level intermediate language for the TILT compiler.
- Complete a compiler for Modal ML which generates real machine code. This will allow us to study careful optimization selection for run-time specialization.

**1.3 Software System Safety Infrastructure****Accomplishments (January-March):**

- Demonstrated Touchstone, a prototype compiler for automatically generating optimized proof-carrying code (PCC) binaries.

**Objectives (April-June):**

- Extend the range of language features and optimizations handled by Touchstone.
- Develop techniques for optimizing the PCC proofs.
- Produce a Foxnet Journal Paper.

**2 Noteworthy Publications**

- Generational Stack Collection and Profile-Driven Pre-Tenuring by Perry Cheng, Robert Harper and Peter Lee. Accepted for publication in PLDI '98. (To appear, June, 1998.)
- How Generic is a Generic Back-End? Using ML-RISC as a Back End for the TILT Compiler. Second Workshop on Types in Compilation, Kyoto, Japan. March, 1998.
- Modal ML and Run-time Code Generation by Philip Wickline, Peter Lee and Frank Pfenning. Accepted for publication in PLDI '98. (To appear, June, 1998.)
- Modal Types as Staging Specifications for Run-time Code Generation by Philip Wickline, Peter Lee, Frank Pfenning and Rowan Davies. CMU Technical Report.
- The Design and Implementation of a Certifying Compiler by George Necula and Peter Lee. Accepted for publication in PLDI '98. (To appear, June, 1998.)

### 3 Capital Equipment Purchases

- 2 IBT560X IBM ThinkPads 560X P233 32/4.0, \$7,898.00
- 1 HEW-HP LaserJet 4000N Printer, \$1,360.00

### 4 Key Personnel Changes

- None.

### 5 Noteworthy Meetings

- ACM SIGPLAN/SIGACT Symposium on Principles of Programming Languages (POPL) (San Diego, CA, January, 1998).
- IFIP WG2.8 Working Group on Functional Programming (Warm Springs, OR, March, 1998).
- 5th Workshop on Foundations of Object Oriented Languages (San Diego, CA, January 17 and January 18, 1998).

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